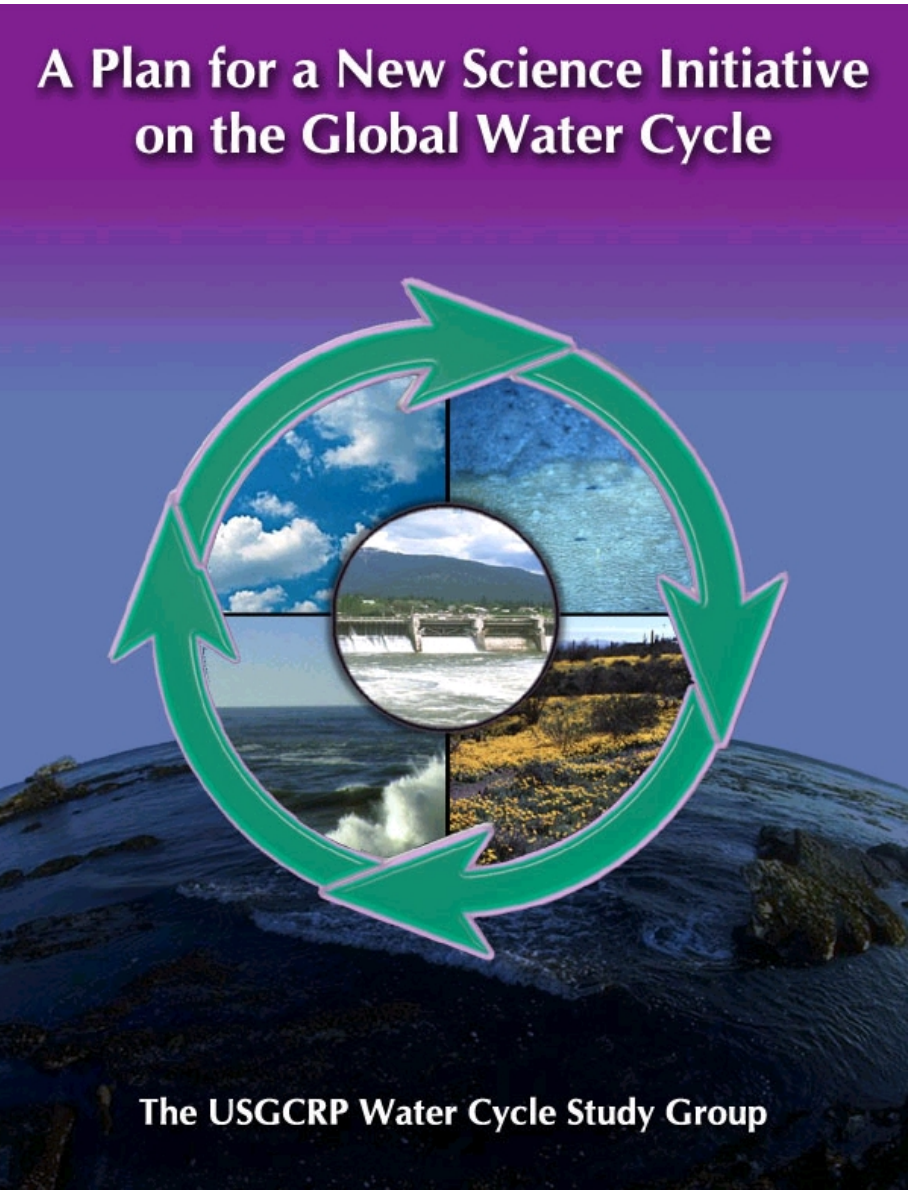


CONTRIBUTION OF GPM TO THE US WATER CYCLE PLAN

Dennis P. Lettenmaier

Department of Civil and Environmental Engineering

University of Washington

Water-cycle web site:

http://ontario.hydro.washington.edu/WaterStudyGroup/

Charge to the Water Cycle Study Group:

to "formulate a research strategy and scientific plan for investigating the global water cycle, its role in climate, and the fundamental processes that govern the availability and the biogeochemistry of water resources, [and to] develop the strategy and science plan for a national program."

USGCRP Water Cycle Study Group

August 1999: the U.S. Global Change Research Program (USGCRP) appointed a Water Cycle Study Group (WCSG).

John Aber
Roger Bales
Jean Bahr
Keith Beven
Efi Foufoula-Georgiou
George Hornberger
Gabriel Katul
James L.Kinter III
Randy Koster
Dennis Lettenmaier
Diane McKnight
Kathleen Miller
Kenneth Mitchell
John Roads
Bridget R Scanlon
Eric Smith

Time line & activities, 1999-2000

- **Open meetings: AGU Dec, 1999; AMS Jan 2000; ASLO Feb 2000.**
- **EOS article to alert the community to the activity and to solicit comments.**
- **Draft plan posted on the Internet, Mar 2000.**
- **Community workshop on 30-31 Mar 2000.**
- **Pre-pub draft on web site, Fall 2000.**
- **Final editing underway, "formal" submission to USGCRP imminent.**

Water Cycle Initiative Rationale

- **Natural climate variability and human activities perturb the fluxes and storages that make up the global water cycle, and these perturbations can have significant societal impacts.**
- **In the face of increasing water demand and other stresses, improvements in prediction are becoming critical.**
- **New technologies for measuring, modeling, and organizing data on the Earth's water cycle offer the promise of deeper understanding of water- cycle processes.**

Science Question I

What are the underlying causes of variation in the water cycle on both global and regional scales, and to what extent is this variation induced by human activity?

- **Goal 1: Quantify variability in the water cycle**
- **Goal 2: Understand the mechanisms underlying variability in the water cycle**
- **Goal 3: Distinguish human induced and natural variations in the water cycle**

Science Question II

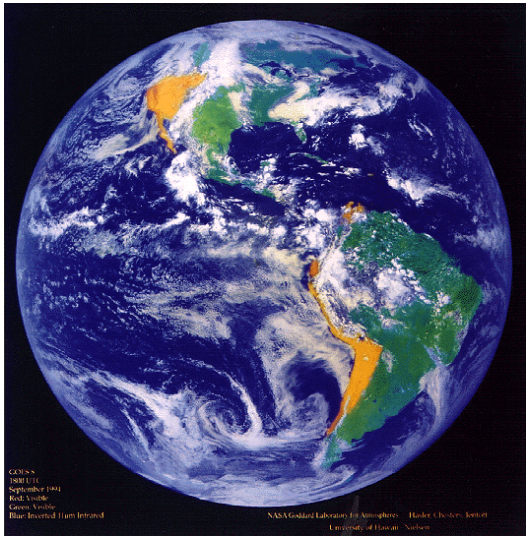
To what extent are variations in the global and regional water cycle predictable?

- **Goal 1: Demonstrate the degree of predictability of variations in the water cycle.**
- **Goal 2: Improve predictions by quantifying fluxes among key hydrologic reservoirs.**
- **Goal 3: Establish a systems modeling framework useful for water-resources management, natural hazard mitigation, decision making, and policy guidance.**

Science Question III

How will variability and changes in the cycling of water though terrestrial and freshwater ecosystems be linked to variability and changes in the cycling of carbon, nitrogen and other nutrients at regional and global scales?

- **Goal 1: Understand the coupling and feedbacks of water, carbon, and nitrogen cycles.**
- **Goal 2: Goal 2: Develop a quantitative predictive framework coupled to ecosystem responses.**
- **Goal 3: Distinguish between human-induced and natural variations.**



PILLAR INITIATIVE #1:

Determine whether or not the global water cycle is intensifying and to what degree human activities are responsible.

Key elements: processes governing distributions of regional and global precipitation, atmospheric water vapor, cloud processes, snow and ice reservoirs, and global ocean fluxes; better observations of pertinent state variables, field experiments, and improvements in coupled atmosphere-land-ocean models.

PILLAR INITIATIVE #2:

Incorporate deeper scientific understanding that is needed to deal with water-cycle calamities into prediction systems.

Key elements: improvement of model predictive skill through testing of models with better observations, explicitly addressing conceptual model and parameter uncertainties, and conducting comparisons among different codes using data from carefully designed field experiments.

PILLAR INITIATIVE #3- Develop the ability to predict cycling of biogeochemical constituents.

Key elements: comprehensive data sets to evaluate effects of land cover change; enhanced, sustained observations of key state variables; numerical modeling to evaluate susceptibility of water resources to climate variability, to snow and ice dynamics, and to land use and land cover changes.

CHAPTER 2: CAUSES OF WATER CYLCE VARIATION ON GLOBAL AND REGIONAL SCALES, AND HUMAN INFLUENCES

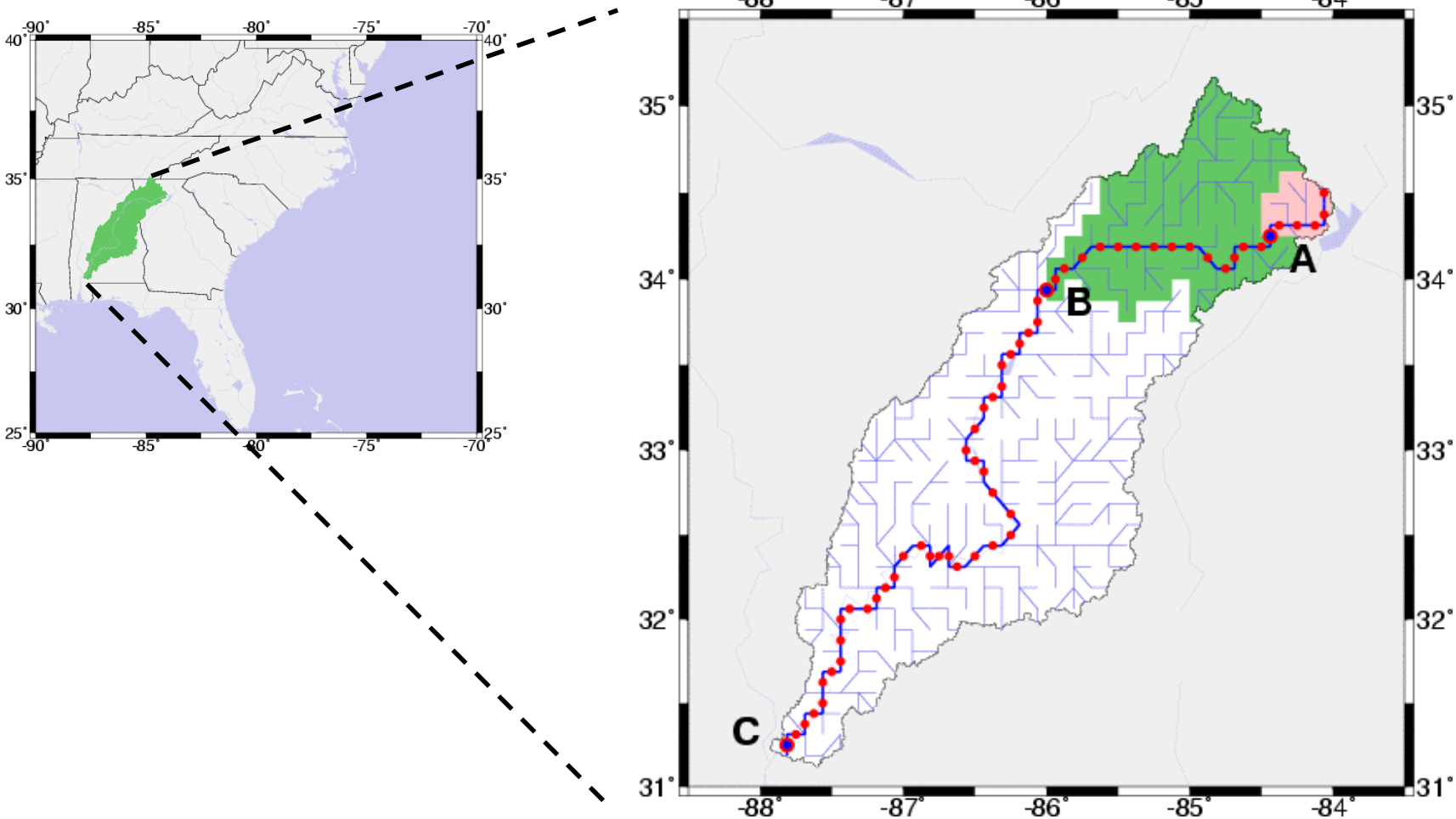
"Deficiencies of existing networks have become apparent in recent devastating floods in areas like Central American (Hurricane Mitch) and Africa (Mozambique floods). Estimating precipitation over oceans is even more problematic. The proposed Global Precipitation Mission … could be the cornerstone of global observations over both oceans and land".

CHAPTER 3: PREDICTABILITY OF VARIATIONS IN GLOBAL AND REGIONAL WATER CYCLES

"Assessing precipitation over the entire globe at sufficiently high resolution will capture its diurnal variability and spatial inhomogeneities to improve understanding of water cycle exchanges and predictions at all scales. The Global Precipitation Mission … could be the cornerstone of the needed effort."

Basin Location

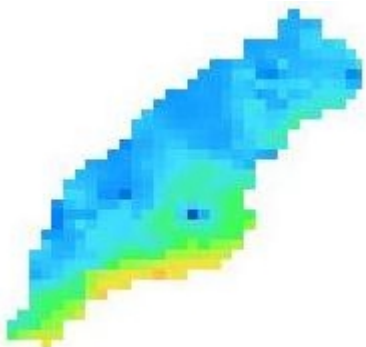
Alabama – Coosa – Tallapoosa (ACT)



Methodology

Imposing Error on Precipitation

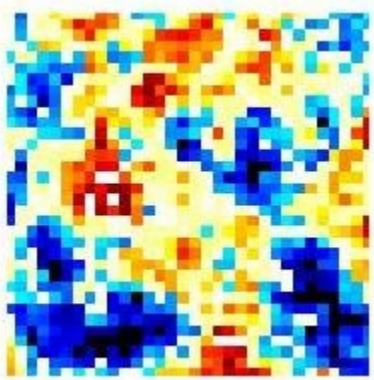
Precipitation over the ACT basin on day X:
"Truth"

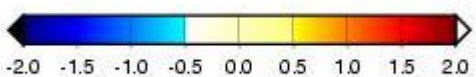


Spatial Gaussian random field:

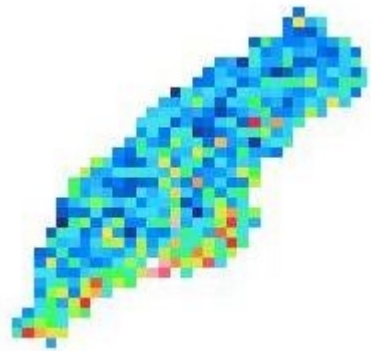
Uncorrelated

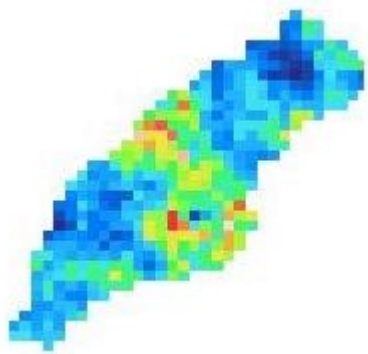
Correlated

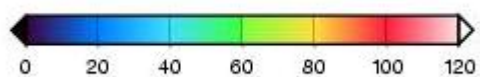




New precipitation fields



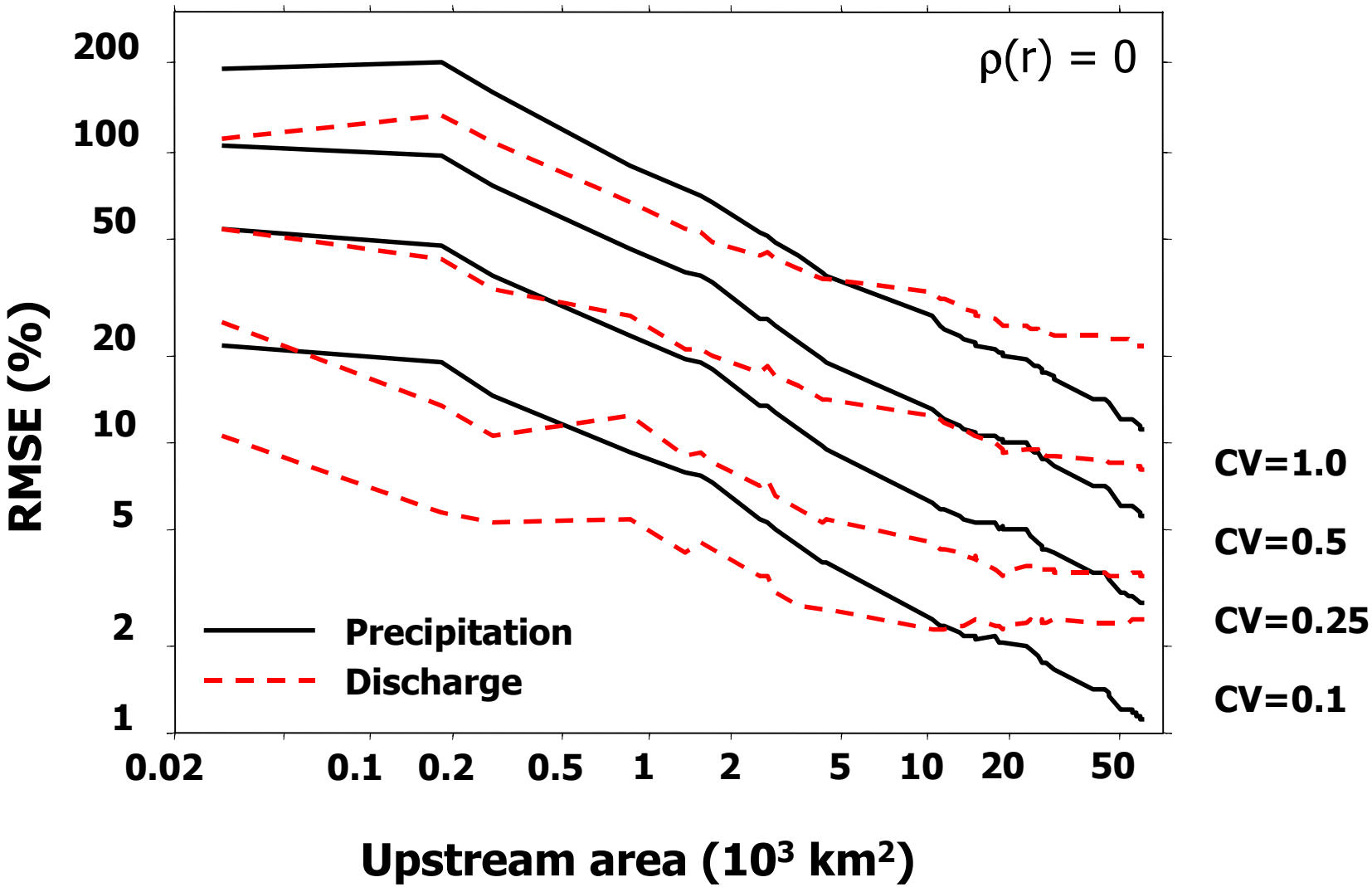




→ **VIC**

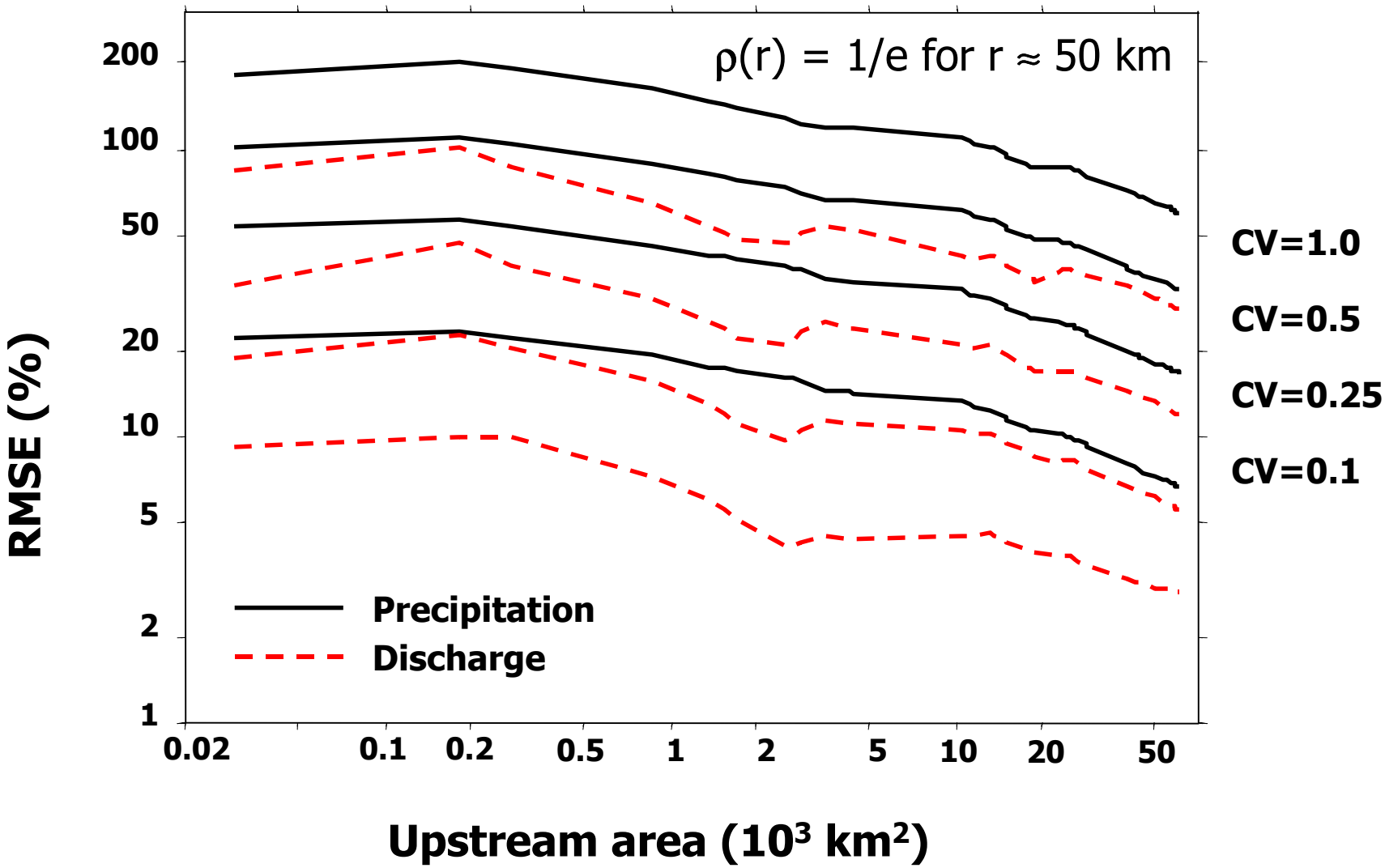
Effect of Imposed Error on Predicted Discharge

Spatially Uncorrelated Case



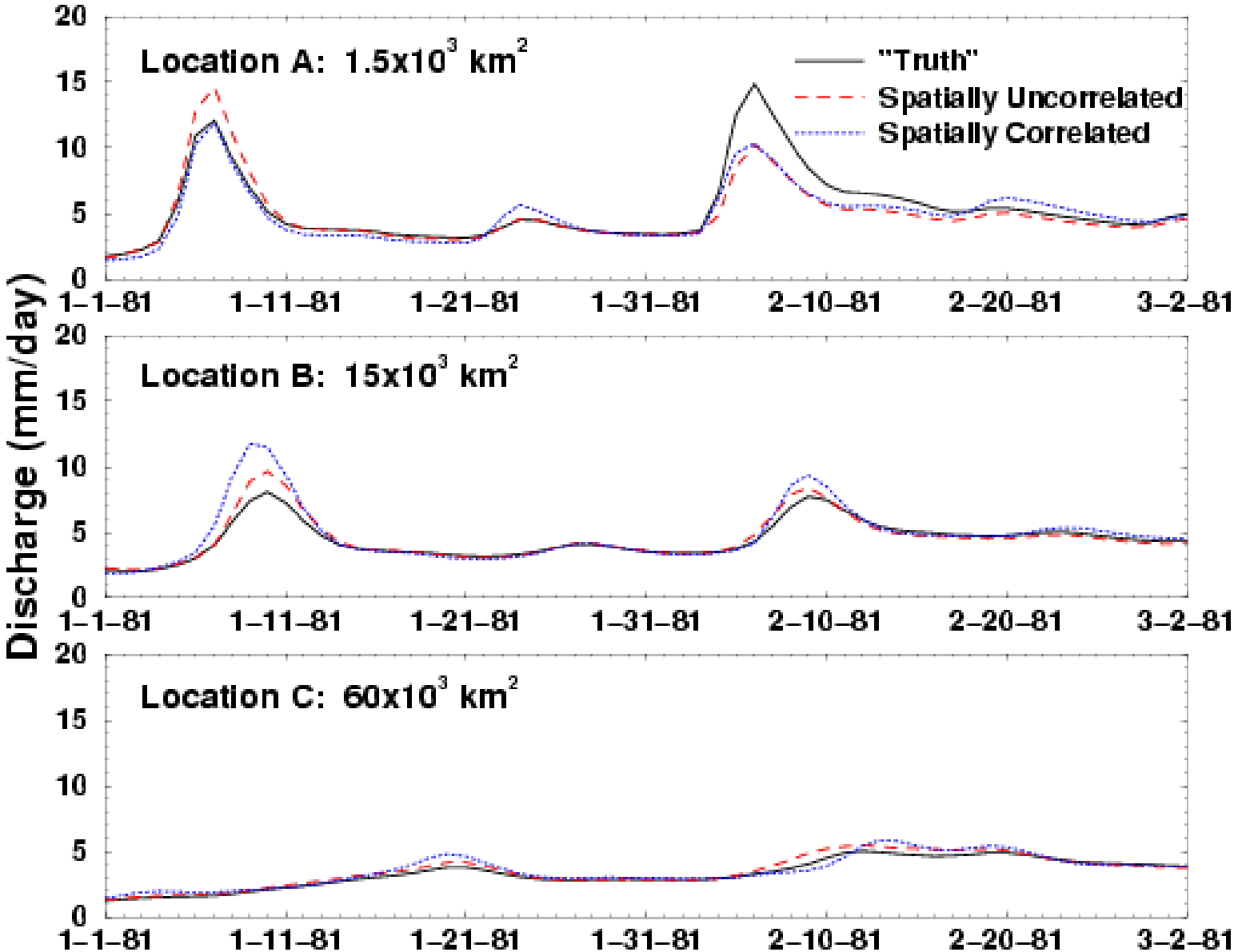
Effect of Imposed Error on Predicted Discharge

Spatially Correlated Case

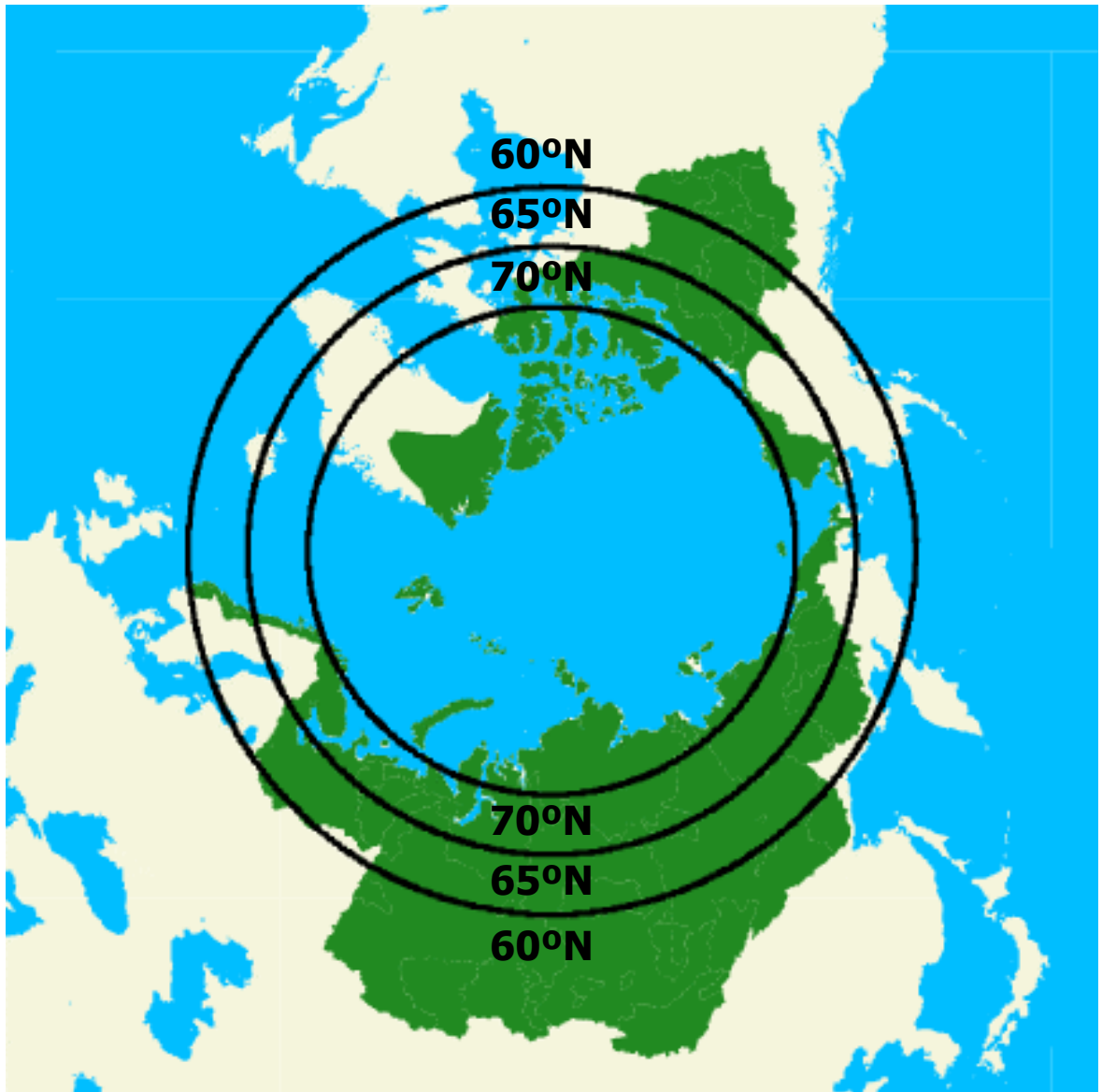


Predicted Discharge at Three Locations

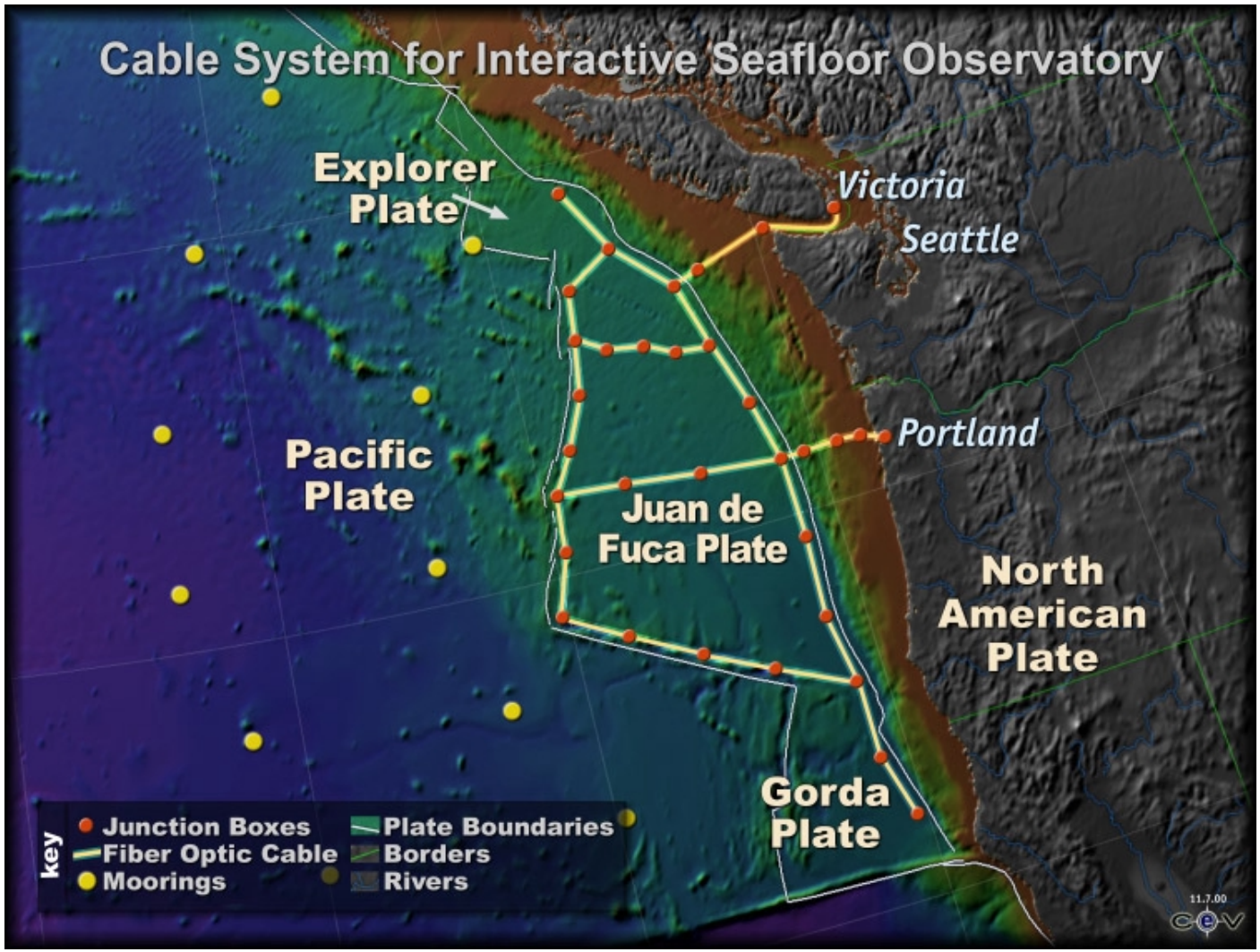
Spatially Uncorrelated and Correlated Case



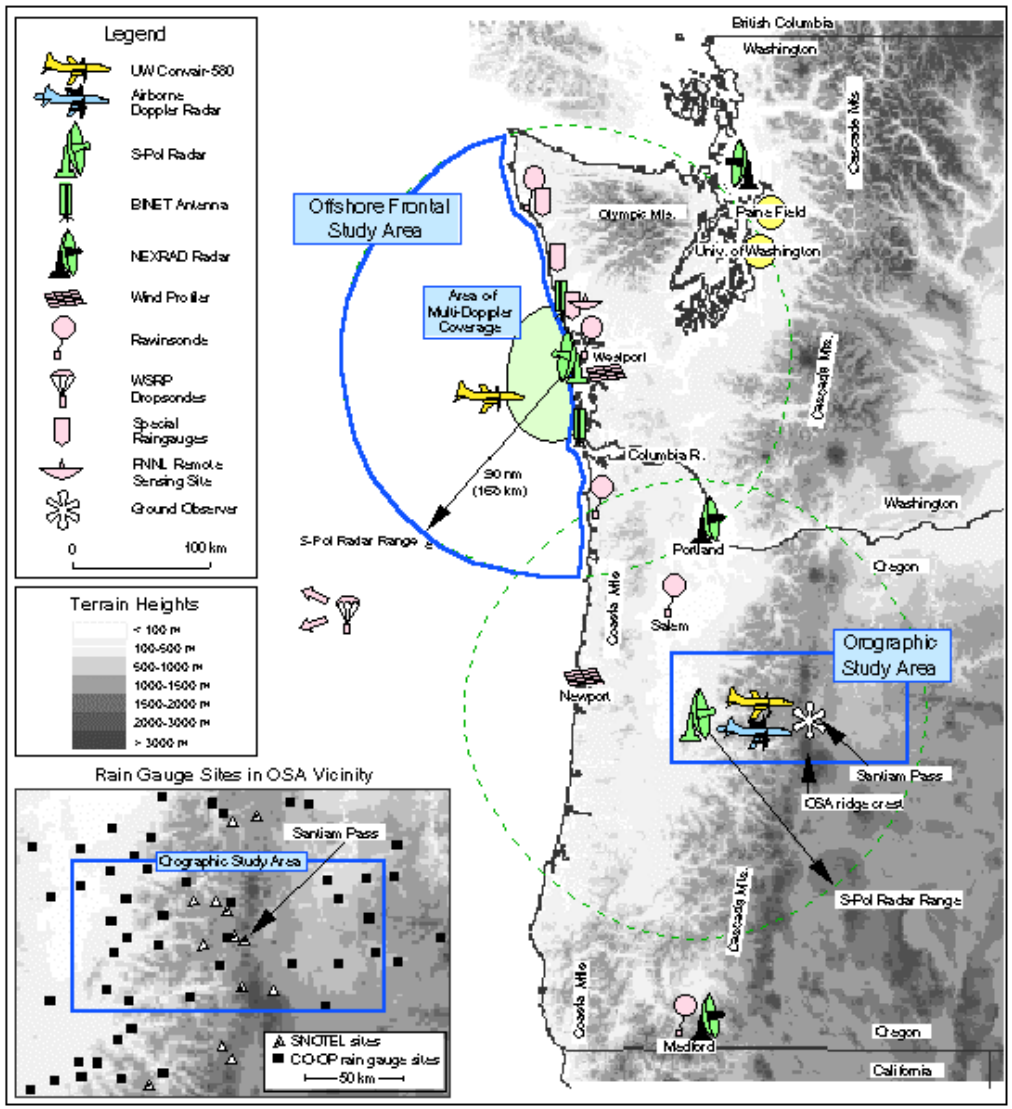
Coverage of the Arctic Basin for Different Orbital Inclinations



NEPTUNE Underwater Cable Network



Observational Platforms in the IMPROVE Project



CONCLUDING REMARKS

- GPM is critical to the evolution of a capability for global hydrologic prediction
- There is a need to develop a constituency for GPM within both the hydrologic science and applications community
- It's essential that estimation of precipitation over land, and in particular its diurnal cycle, be and remain a central objective of GPM